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Directors of Warp Sizing Research

THE committee having charge of the administration of U. S. Institute's research on warp sizing (Wright Bolton, Chm., Dr. J. B. Quig, Dr. H. A. Neville) announce the appointment of Dr. J. A. Katz as director of the study, and of William E. Yelland, S.B., as assistant director. Dr. Katz has been at Cornell University since last Fall as Baker non-resident lecturer in the Department of Chemistry and has just completed a series of lectures at universities in the Middle West. Since 1918 he has been associated with Amsterdam (Holland) University as lecturer on colloidal and physical chemistry. He is known by scientists throughout the world as one of the most eminent authorities on substances of high molecular weight, and particularly on X-ray spectrography of starch. From 1912 to 1917 he specialized on bread-making and the staling of bread. From 1927 to 1935 he worked intensively upon X-ray spectrography, gelatinization, setting-back and aging of starch. He is to conduct a series of lectures at M. I. T., at which institution U. S. Institute's warp sizing study is to be conducted through the Division of Industrial Co-operation, and it was this fortunate combination of circumstances that made it possible for U. S. Institute to secure the services of Dr. Katz.

William E. Yelland, assistant director of the warp sizing research, has been associated with M. I. T. since his graduation in 1930 as a graduate student, laboratory assistant and part-time instructor in analytical, inorganic, organic and physical chemistry, and is now completing his thesis for the Ph.D. degree in organic chemistry. He is highly recommended by all M. I. T. professors under whom he has worked, and was the unanimous choice of our administration committee and of Prof. C. L. Norton, director of M. I. T.'s Department of Industrial Co-operation, and of Prof. Schwarz, who will act as M. I. T.'s contact representative for this study.

A survey of existing knowledge of starches, gelatines, and other substances of high molecular weight that are, or may be,

(Continued on page 339)

Micro-Analysis of Textile Fibres

Part III.—Observations on the Structure of Cotton

By G. GORDON OSBORNE*

(*Continued from Vol. V, No. 6*)

PITTS.—It would seem that these structures (Fig. 10) are produced by a combination of fissures or buckling lines with a lateral differential displacement of one or more fibril layers. Fig. 8, based on a series of photomicrographs and sketches, illustrates such structures, their mutual relationships, and their possible successive changes. Thus, given the structure previously described (fissures or pleats) and a tensioning of the hair with differential displacement (fibril separation and slipping), the results may be the type of pit illustrated in the photomicrographs (Fig. 10),

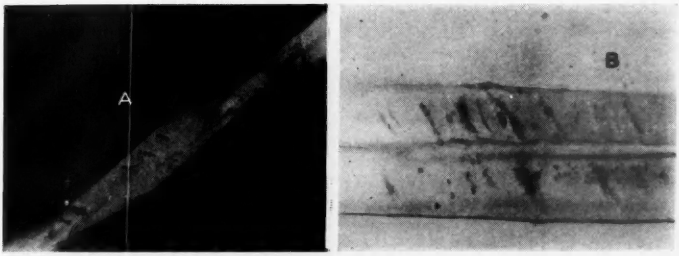

FIG. 10. Two views of cell-wall pitts.

and unfortunately termed "stomata" by DeMosenthal. Further evidence in this direction is given by Denham,[14] who reports that although slip planes and buckling lines may be found in freshly taken fibres, no evidence of pits is obtainable. And further that straightening (tensioning) previously unmarred hairs has often been seen to be the cause of this defect. It is this structure that, in the capillary rotator, has been shown to be somewhat of a projection from the fibre surface. Thus the rim formed around each slit, or cup-like pit or opening, stands out from the fibre like the crater of a volcano.

The extent of the actual penetration of these pits into the wall of the fibre has not been definitely ascertained. Inspection by incident light, and

* Mr. Osborne, as a Senior Fellow of the Textile Foundation, worked under the direction of Prof. E. R. Schwarz, Massachusetts Institute of Technology, Cambridge, Mass.

the use of stains and casts, indicate, however, that a pit depression is not very deep, is covered with a normal thickness of cuticle, and has therefore no more influence on moisture, chemical or dyestuff absorption than the more normal surfaces of the hair. Furthermore, no evidence of pore structure was discovered in connection with any of these irregularities.

PORES.—Perhaps it should be stated here that in a large number of observations on cotton, as well as on different bast fibre cells, no structure suggestive of the gross pore illustrations of Nodder,* [26] or DeMosenthal,[27] has been seen. There is, however, absolutely no doubt (numerous botanical examples can be cited) that a pore structure does exist † and is of the utmost importance both to the growing cell and afterwards to the processing chemist, but it is believed to be, though numerous, so small as to be beyond the range of the most powerful microscope.

ABNORMALITIES.—The microscopical inspection of a large number of cotton hairs will reveal the presence of several types of abnormal growth. There appear to be three main divisions into which such structures can be divided. They are (1) branched or split hairs, (2) strophoid or curved hairs, and (3) spur-growth fibres; the latter, reported by Deschamps,‡ have not been seen in this study and are apparently indigenous to Indian cottons.

The split hairs are the scarcer of the two abnormalities encountered. They generally consist of a double branch near the tip of an otherwise ordinary fibre, and both parts are well filled with secondary thickening. The irregularities of the strophoid hairs appear to occur anywhere along the length of the fibre. Sometimes they resemble hard granular protrusions completely encircling the fibre for short distances, but more often they are thin, broad, well flattened structures in the form of "dog-legs" or ragged ellipsoids. These appear to occur almost without fail at a point where the hair changes its direction in growth. They may be caused by a weakness in the cell wall which allows enlargement, followed by compression.

POLARIZED LIGHT.—As for other fibres, there are two main advantages in the use of polarized light for the study of cotton fibre structure. First, the use of controlled light in which only one ray is used (the ordinary ray being totally reflected) improves the resolution of the specimen under observation, besides reducing the possibility of causing deceiving optical effects, such as interference and diffraction patterns. Secondly, and more important in this case, such light reveals much otherwise poorly-resolved structure and allows certain predictions as to its physical properties to be made.

Probably the first point regarding cotton, and certainly one of the most characteristic, is the reaction it displays when rotated between crossed nicols. Previous work by the author [1] and others [28] on bast fibre cells, and

* It seems extremely improbable that the pores shown in the high-powered drawings of this author for flax and cotton are as depicted. Their relatively enormous size and general configuration suggest that they are either pitts piercing the cell wall, as is common in the cells of coniferous woods, or the passage left by the penetrating hyphae of some cellulose digesting fungi.

† Clegg and Harland,[8] in a unique investigation, have determined a fairly precise approximation for the "pore space" in different cottons. Using the formula $d = \frac{m}{n}(n + a)$ where d = the density, m = the weight of n fibres 1 cm. long, and a the average cross-section area, they figured that in a typical instance the computed volume would be .88 cc. per gram, while the specific volume, using a water immersion method, gave .63 cc. per gram. Thus .25 cc. or 30% of the volume was "pore space." For different cottons this measure of porosity ranged from 30 to 40% of the volume of the hair, being greatest in the coarsest cottons.

‡ "Etudes elementaires sur le coton." Rouen, 1885.

particularly flax, ramie and jute, had clearly shown that these specimens gave almost complete parallel extinction when aligned with either of the nicols' planes. Such is not the case with normal cotton hairs; their appearance in a similar position is but slightly dimmer than that at 45°—the position of maximum brilliance for cotton, as well as for the bast fibre cells. This decidedly unique reaction in a fibre chemically very similar, would indicate a radical physical or structural difference, but before taking this up it would be well first to enumerate several other salient characteristics.

The spiral fibrillae shown in ordinary light by pressure technique, and the pit spirals between each fibril, are more readily seen in normal cotton with polarized light. If the hair is placed parallel with either polarization plane, the points of reversal (where the fibrils change the direction and inclination of their helix) appear as narrow, dark-black bands traversing the otherwise bright surface (Fig. 13). The addition of a selenite plate will further emphasize this reversal; lengths * on either side of an extinction band standing out in bright complementary color, which alternate with every quadrant upon rotation. This effect (see the series of photomicrographs of Fig. 12) will hold until the specimen is well advanced in disintegration, although there seems to be a greater tendency for acid (H_2SO_4) to reduce this than alkali (NaOH).

The narrow extinction band observed at reversal positions, when the hair is between crossed nicols, is of great interest; for this is the only point where the helically spiraling fibrils are parallel to the longitudinal axis of the fibre. Inspection of Photomicrograph No. 2 (Fig. 13) will show by the narrowness of the black line that the parallel distance so occupied is not great and that the fibrils closely follow the pattern in Sketch No. 2, Fig. 11. Also complete specimen inspection by means of capillary-tube rotation shows this band to extend, as expected, completely around the fibre, and to be very closely normal to the longitudinal axis all the way.

(Correlation between this extinction plane—reversal point—and visible convolution shape cannot be made positively with fixed-specimen mounts, as the broad fields of the fibre are determined by the spiraling of the convolutions. There is, however, a tendency for extinction points to be in the centre of such fields.)

Recalling that spiraling bands, even though reversing at irregular points, appear to reverse the direction of their spirality on the under side when viewed through from the upper, led to the following experiments to explain the non-extinction of the fibre as just described: Longitudinal split sections of normal cotton fibres were made by the method previously described,[5] or by direct splitting under a binocular stereoscopic microscope with the aid of a fine cataract lancet. These were mounted in balsam with the exposed plane facing upward, carefully covered with cover glasses and inspected between crossed nicols. It was found that when a hair had been bisected nearly perfectly longitudinally, and lay open without spiraling or curling, so as to present a flat, severed surface normal to visual inspection, extinction would be almost complete when the longitudinal fibril axes coincided with either plane of polarization.

* The division is not perfect. For short distances on either side of the dividing color line small spots or islands of the opposite color show up clearly (sketch No. 1 of Fig. 11) definitely showing a small deposit of physically differing cellulose.

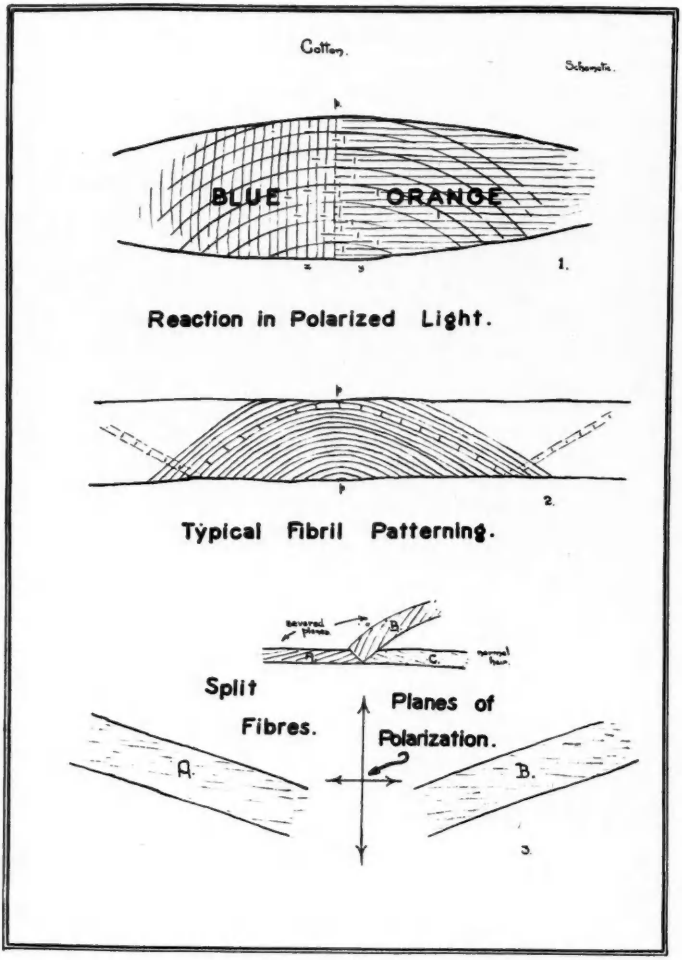
Cotton.
Schematic.
BLUE
ORANGE
1.
Reaction in Polarized Light.
2.
Typical Fibril Patterning.
several planes
B.
C.
normal hair.
Split
Fibres.
Planes of
Polarization.
A.
B.
3.

FIG. 11.

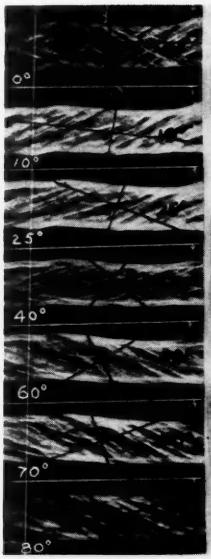

FIG. 12.

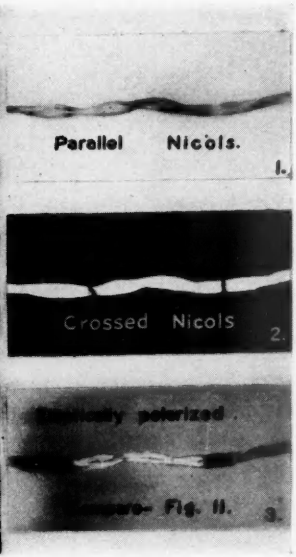

FIG. 13.

Such sectioning, of course, disturbs the normal angular relationship between fibrils and fibre, and, as each specimen is in itself different, no definite extinction angle was obtained. Furthermore, if the specimen is not equally split, or if it assumes a creased or overturned position (as is generally the case), the extinction angle varies largely, ranging from 0 degrees (perfect parallel extinction) to a maximum observed angle of 36°. Fortunately, however, several specimens in this experiment showed a very raggedly severed plane (Photomicrograph No. 2, Fig. 14) from which many extremely fine fibrils projected in random order, much like the feather barbs from a quill; these, as all other small fibril units, gave as complete parallel extinction as any of the bast fibre cell specimens. Photomicrographs Nos. 1 and 2, Fig. 14, show two typical sections, while Sketch No. 3, Fig. 11, is drawn to illustrate the tendency of longitudinally split cotton fibres to become extinct when aligned with either of the nicols' planes.

At first this would seem to indicate that it was the relatively steep angle of inclination of the fibrils, plus the fact that the usual microscopical investigation cannot disregard the under half of the specimen to eliminate the confusion of a seemingly contradictory reversing of fibril spirality, that accounts for native cotton's very slight dimming when parallel to a nicols' plane. Morey,* however, has listed three factors which make the front (top) layer only effective in such measurements. They

* Morey, D. F. *Tex. Rsch., IV,* 491–512 (1934).

are: (1) the back layer is slightly out of focus and less light is available; (2) there is absorption and scattering of light from the back portion as it passes through the rest of the fibre; (3) the doubly refractive nature of the front surface causes transmitted light to lose its original characteristics and become more representative of the directional properties of the front wall. Therefore it is not solely conflicting spirality and strong inclination that account for the fibre's continued brightness between crossed nicols.

The fact that split cotton sections and unit fibril groups show the same reactions as bast fibre cell specimens (while the normal cotton fibre differs) is an indication that the theory [29, 30] of reversing spirality in alternate lamellae does not hold. Such a contention postulates a reversal of direction of fibrils in each growth layer, so that the final product gives a lattice structure in every part of the hair. If this were the case, and each cellulose layer differed in the direction of the helical fibrils, bisected longi-

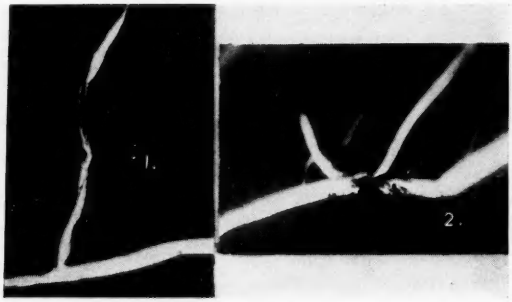

FIG. 14.

tudinal sections would react in the same manner as normal hairs and not show strong parallel extinction tendencies.

As in flax, evidence is abundant that the strong polarizing effects of the cotton fibre are not chiefly due to internal strains occurring either in growth or handling as claimed by Harrison.[7] Thus normal cotton fibre, ground for 21 days in a ball mill until the average size of the cellulose particles was but 1 to 2 μ, still showed polarizing effects; and fibres reduced by chemicals and agitation to almost dust, in aqueous medium where all strains tend to neutralize, still show strong birefringence.

Fig. 15 shows a single cotton fibre between crossed nicols and mounted in 5% H_2SO_4. Three stages of breakdown may be seen. At Photomicrograph No. 1 a point of spiral reversal is clearly evident, as well as the first swelling and separation of the cell wall. Photomicrograph No. 2 shows almost complete separation of the wall into gross fibril complexes, with some transverse breakdown; while Photomicrograph No. 3 shows severe fibril shattering. Note particularly the small particles which, upon further agitation, pass beyond the range of microscopic vision, but continue to show double refraction.

Of interest is the action of a normal fibre again between crossed nicols when treated with $Cu(NH_3)_4(OH)_2$. The specimen at first shows the usual appearance, and, as expected, becomes dimmer and dimmer as the cellulose approaches its solution point. The centre of the "bead" formation is the first to dissolve and this area becomes dark; however, where the tightly coiled cuticle produces the strangulation points, the reagent enters slowly and so the fibre shows a more normal aspect here for a longer time. There is, however, another tendency at work which emphasizes this more natural appearance. An internal strain is produced between the cellulose itself, which tries to expand, and the cuticle membrane, which acts as a restricting collar. This, together with the less damaged structure at the strangulation points, produces the appearance shown in Photomicrographs No. 2 and 4 of Fig. 2.

Cross-sections in polarized light approximate bilateral symmetry. This is best shown in sections that have been treated with 16% NaOH. As a means of interpreting structure, however, they are somewhat dubious—the

FIG. 15.

cutting impact of the microtome blow being more than enough to alter structure besides changing dimensional attributes. By means of a Bertrand lens in the polarizing microscope faint uniaxial interference figures have been obtained from thick sections; these too are open to speculation and reproducible results have not been obtained. Of more interest, however, is the phenomenon previously reported for flax * of a decidedly brighter narrow ring around the outside of the transverse section. It has been interpreted as the shell of the outer primary wall and its differential brightness may be explained by Reimer's experiments,[31, 32] which showed that, although the longest axis of the index ellipsoid was in the same direction as the fibrils, it was at a steeper slope than that of the index ellipsoid in the secondary layers.

Fortunately, the great economic importance of cotton has led to the concentration of a wide variety of investigations upon it. Indeed, so much so is this the case, that to-day there is a considerable degree of agreement concerning its chief characteristics. In order to aid in a full understanding of the research, a brief resumé of the molecular structure, as well as some other vital attributes, of cotton will be given.

* Osborne, G. G. Report to the Textile Foundation, Sept. 1, 1933. (To be published in *Tex. Rsch.*)

MOLECULAR STRUCTURE.—As is to be expected, the main tools for such a purpose are chemical and X-ray analysis. Numerous workers [33, 34, 35] in these fields have established fairly definitely the cellulose make-up to be as given by the formula of Figs. 16a and 16b. Cotton is thus composed of a continuous chain of cellobiose residues, or six-ring glucose residues in pairs. These chain-like molecules are individually fibrous, but are easily broken chemically with the reactive groups at the ends fairly accessible

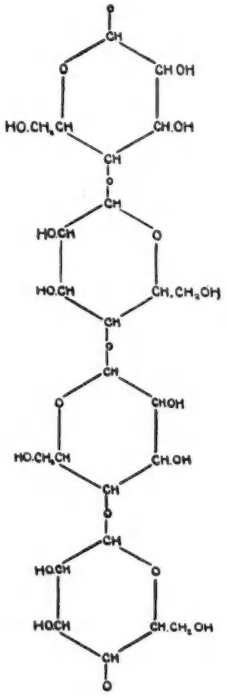

FIG. 16a.

to reagents. Chemical evidence is such as to preclude the view of more than one type of cellulose in the secondary deposit, although the length of the chains is variable and indefinite. These molecular chains are held together longitudinally by principal valence forces consisting of oxygen bridges. The identity period along the fibre axis has been found to be 10.3 Å from the X-ray diffraction patterns. The additional dimensions of the unit cell from mathematical considerations prove to be 8.3 Å and 7.9 Å, with an 84° angle between them. A similar attack [34] has shown the length

of the cellulose micelle along the axis to be 500 Å, and the dimensions normal to this, 50 Å. As seen from the diagram, the atoms are well fitted together and the arrangement is plausible. X-rays show an interruption of the regular repetition of the crystal planes at short intervals, and it has been suggested [36] that this represents a molecular order only approximating to crystalline perfection; interspersed partial local discontinuities having a similar effect (in diffraction) to the continuous boundaries of the crystallites.

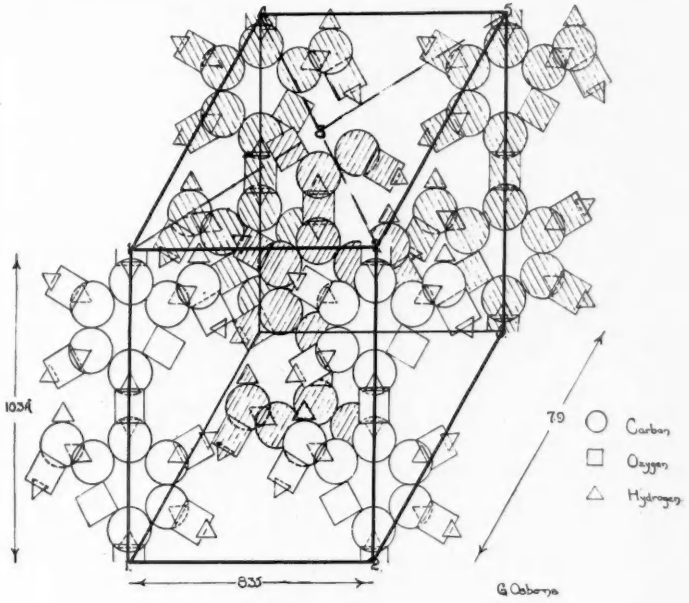

FIG. 16b.

On the whole, however, the structure is continuous and regular, but it has again been postulated [37] that the large unsaturated molecules allow a local interplay between the ideal of the molecular forces and the actualities of the cell-wall surfaces; between crystal and hair forms. Probably, during the daily rest period, the crystal ideal is more perfectly attained, making an internal surface with less potential energy and normal cohesion, which may be made visible as a growth ring afterward by suitable treatment. The fundamental picture of cellulose is, then, a monoclinic crystal of three unequal axes, one perpendicular to the plane of the other two which make an 84° angle with each other. The chains are held laterally within the unit by secondary or Van der Wall forces,[38] which arise principally in the OH groups. The unit crystallites are built up by nature

into micelles of definite size. Their length additions approximate 500 Å and their lateral compacting 50 Å. A break occurs at these restraining limits and another micelle forms. The forces holding the micelles in position come from the same chemical groups as the secondary forces, but are considerably weaker due to the imperfect arrangement of the micelles either accidentally or in connection with growth. Such sizes are, of course, well beyond the limits of microscopic visibility. However, a mass effect can be seen, as the micelles are bound together in turn to form the fibrils that in gross structure may be seen upon swelling and compression.

Fibrillar Structure.—A single cotton fibre in 8% sulphuric acid with iodine is shown in Fig. 17. The end of the fibre, which appears in the

Fig. 17.

upper portion of the photomicrograph, had been severed cleanly. Fibrils, singly and in groups (stained a bright blue), are clearly evident. There is no noticeable tendency for these to assume a position parallel with the fibre axis; although, in small longitudinal sections, the fibrils appear to have changed their inclined position for one nearly parallel with the fibre axis. Actually, however, no direct evidence of this has been observed. Narrow longitudinal sections naturally follow the path of the fibrils and, when separated from the body of the fibre, seem to have come from a position directionally aligned with it.

These fibrils are extremely resistant to further distinctive action. They appear to have separated from a possible embedding matrix which has been either dissolved or washed away, although this conception is not essential.* Such small particles as those constituting the body of the fibre, are easily held together most firmly by cohesive forces in the natural state—but are quickly neutralized in liquid media.

* See Sir Geo. Beilby. "Aggregation and Flow of Solids." London, 1921.

STRUCTURE OF CELL WALL.—It is, however, upon the unit structure that a mathematical analysis is laid in an attempt to explain the make-up of the cell wall. Before proceeding with this it may be well to give a brief review of the most widely accepted theory of cotton wall growth. This, as mentioned before, is mainly due to Balls' physiological investigations in Egypt. Thickening begins as soon as length extension ceases and is an intermittent process; stopping during the heat of the late day and reaching a maximum at night. This periodic deposition results in the stratified structure or lamella which is commonly known to all plant anatomists. Balls, furthermore, postulated that, in addition to this concentric arrangement, a definite radial pattern for deposition was determined during outward extension. This was adhered to faithfully throughout all stages of secondary thickening, the course of the first fibril being followed exactly by subsequent similar members occurring at the same circumferential point, until a true "spoke" arrangement was evolved. From this it follows that there is an unbroken sequence and equal number of unit cellulose deposits in every growth ring—further illustrated in the diagrammatic sketches of Fig. 18; a contention which, on considering the geometrical shape of the growing hair (circular) and the inward construction of the deposit, seems questionable.

The following calculations, based on a purely theoretical structure, show the changes that would occur in the internal concentric thickening of a cylinder. The dimensions have been changed to Angstrom units throughout and the calculations relate to various points in the hair proceeding from the outside to the center. The average dimensional attributes of a fibre just before collapse are taken as 12 μ in diameter with 5 μ wall thickness. There would be, therefore, 1000 micelles per wall thickness, and calculations show the changes that occur in building in from the primary wall to the lumen at the following points: (1) O—inside of primary wall; (2) 250; (3) 500; (4) 750 micelle mark, and (5) 1000 micelle mark, or lumen wall.

The calculations are briefly summarized below: Micelles per circumference are found, as the equation shows, by dividing the circumference at each deposit layer by the width of the micelle at this layer.

$$\text{Micelles per growth-ring} = \frac{\pi[\text{Do} - 2(\text{n} - 1)\,\text{d}]}{\frac{50}{\text{Cos}\ \alpha_n}}$$

where: Do = full diameter of secondary cellulose
d = thickness of one micelle
n = number of micelles from outside of secondary cellulose deposit

and: $\text{Tan}\ \alpha_n = \frac{r_n}{r_o} \tan \alpha_o$

where: r = radius of secondary deposit

The approximate numbers of micelles per growth ring (circumference) at the above-mentioned points prove to be:

(1) 6900; (2) 5800; (3) 4250; (4) 2850; (5) 1320.

This radical reduction in the theoretical number of micelles per layer is important. Admittedly, this is figured on the basis of equal and intimate micelle spacing throughout each layer, which direct observance tends to disprove; nevertheless, the conception of a rigid pattern throughout and around each lamella, even with unequal spacing and large separation on the

outside perimeters, seems untenable. That wide, empty arcs (pits) do not exist is proven on inspection. That there is some close packing between deposit units on inner lamellae is probably true. As in flax, cross-sections swollen in alkali show a differential reaction between inner and

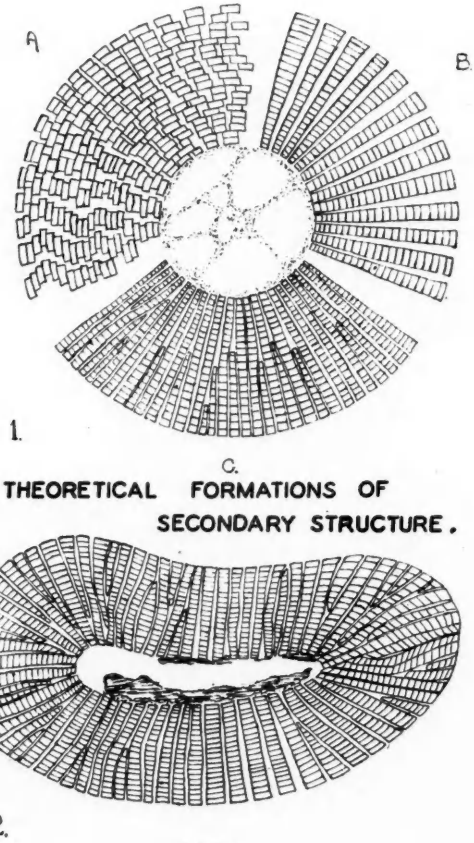

FIG. 18.

outer rings. Thus, if the section splits, due to radial imperfection, the inner sections expand to a greater percentage through those composing the outer lamellae. These sections were cut, however, from desiccated hairs, where there is a natural compressive action at the ends of the major axis (readily shown by the deeper absorption of dyestuff at these points) but

this alone is not enough to account for the increased swelling effect, which is undoubtedly largely due to tighter packing action.

Indeed from the structure of larger fibre cells (tropical woods), where no treatment is necessary to show either their radial or concentric structure, it is clearly apparent that the smallest microscopically visible units are not arranged radially in any definite order, but are quite irregular as regards lengths and continuations from the outside lamella to the lumen.[39] Thus many "spokes," starting from the outermost lamella, are seen to terminate at more or less remote distances from the lumen when the increased packing of other radial lines of deposits becomes appreciable. Furthermore, it is interesting to see that the first concentric or growth ring deposits are broader and more massive than those formed in later stages; a fact commented upon by other observers as applying to cotton also. In fact, a study of such sections would indicate a structure built up much more after the random style illustrated in part C of Fig. 18, rather than the more severe patterning shown in part B, after Balls' description. Actually, from what will be discussed later, the conclusion will rest as favoring a formation illustrated in part A (a combination of the other two).

Growth Phenomena.—To return to the actual growth phenomena in an attempt to explain the formation of the spiro-fibrillae, we may note that botanists have long known of the close correlation existing between protoplasmic streaming and deposit striations. Thus, cellulose thickenings have been shown to originate beneath protoplasmic streams which remained streaming for some time at one place and in one direction on the inner side of a cell wall.[40, 41, 42, 17] The approximately uniform movement of the stream about the cell, and the general smoothness and evenness of its deposit, are produced through rotation, and the origin of this motion is conditioned on the fact that the protoplasm is brought into definite channels around the inside cell wall by the vacuoles in the lumen, which, steadily increasing in size (as hair growth continues), move and guide it from position to position. Under each of these stops a fibrillar-micellar arrangement is laid down, and the process is continuous in cotton until the bursting of the ripened boll.

This relationship between protoplasmic flow and wall striations has been accepted for cotton by Denham.[43] He observed spiral protoplasmic streams in carefully-handled, young cotton fibre taken directly from growing bolls. Such an examination further shows that a very granular structure of the protoplasm is conspicuous in the streams (a symptom of cellulose deposit), especially in the innermost layers, while the outer layer is stationary and hyaline. As a consequence of this it is possible to imagine on the inside of the hair, or even on the inside of each lamella, the formation of ridges of cell wall substance—the spiro-fibrillae. Denham also attributes the presence of his two "weakness belts" to the occurrence of planes in the cell's cylinder free from protoplasmic streaming.

This is as far as present investigations appear to proceed,—with a host of phenomena still unexplained! No work has as yet been discovered which would allow a conclusive answer to be given to such questions as whether cotton cell wall thickening always occurs by deposition of new wall lamellae against those already formed—the theory of opposition as first advanced by Von Mohl; or whether growth in this stage may not sometimes occur by intussusception—Nageli's hypothesis. Neither has it been determined

whether, after the building-up of the wall, differentiation might not occur, which is another way in which the structure of the lamella might arise. However, in reality, evidence points to the probability of a combination, sometimes jointly and sometimes alone, of all these.

Perhaps a simpler explanation, and one which allows a more complete understanding of various other peculiarities, is to consider the formation of the fibrillae as due to protoplasmic streaming along fairly definitely oriented channels on the cell wall, in contradistinction to small, less definite and quite feeble areas where streaming is irregular. In the regular flow-beds the cellulose deposit units would assume an oriented and concentrated arrangement, while in the random streaming regions they would be scantily deposited and in irregular order. These latter areas would, therefore, be mechanically weaker, tending to split and show the more compact spirofibrils; they would behave differently in swelling, dissolving more readily; and their general ability to resist destruction through maceration, compression, or even micro-organisms would be small.

Such information again brings up the question of the connection between secondary-thickening lamellae and daily growth. Despite the correlation of Balls between deposit layers and periodic cessation of growth, no evidence of an elimination or reduction in the number of these concentric layers under artificially constant growing conditions is observed; nor is there any change in cottons from more uniformly climated countries. In fact, this sunshine-cessation effect has previously been considered insufficient to account for this phenomenon.

It has recently been discovered [44] that the nitrogen content of the leaves of the cotton plant waxes during the sunlight hours and wanes at night; further, that in plants without bolls the nitrogen in the bark shows a similar fluctuation, while in boll-bearing plants the nitrogen in the bark downward from the foliage level shows no appreciable change. From this it has been postulated [45] that there may be differences in the cellulose deposited on the inner cell wall from hour to hour sufficient to give it slightly different optical properties, especially when swollen. Indeed, Herzog [46] has reported that he found the cell wall to be built up of concentric layers of cellulose of different optical density.

Another contention advanced to explain this relationship is that the visibility of these lamellae may be due only to a difference in moisture content. Substantial backing for this is found in the work of Van Wisselingh,[47] who succeeded in finding differences in chemical composition in the layers of all the plant cell walls he analyzed. Such differences, it should be pointed out, would produce differences in the degree of swelling and consequently water content; so the two views are mutually agreeable and sustaining.

Ludtke,[48] however, conceives a more elaborate set-up, picturing plant fibres in general as being divided up into a series of thin concentric rings, each of which is separated from its neighbor by a fine skin or membrane of furfurvid substance. This separating membrane is easily visible on dissecting such large structures as *narcissi* bulbs; but the general opinion of the botanists appears to be contrary to this idea as applied to cotton cell-wall structure.

Possibly, for the present, the best answer from Balls' work is to say that the existence of the lamella structure is in consequence of the existence of growth zones, which may be explained by variations in plant metabolism or one-sided impregnation with certain products of metabolism. This would

also help to explain why such formations cannot always be made to appear in specimens from the same sample prepared under identical conditions. In fact, occasionally certain cross-sections from a different part of the same fibre appear completely blank in this respect.

It would perhaps be well to mention here some aspects of a recently advanced theory concerning "The Formation of Cellulose Membranes by Microscopic Particles of Uniform Size in Linear Arrangement." This work by Farr and Eckerson [49] reports the existence in growing cotton fibres of cellulose particles covered by a thin layer of pectic substance singly and in bead-like strands. A single strand of these coated cellulose units is said to form a fibril in the wall of a cotton fibre. Similarly, gentle and non-distorting dissolving of fresh or desiccated cotton hairs, plus slight mechanical action, shows particles of uniform size (ellipsoids of approximately 1 to 1.5 μ in diameter; compare the dimensions noted on P. 317) which are stated to be identical with those present in the cytoplasm of the young fibre.

The existence of such chain-like particles, and the role ascribed to them in the formation of the fibrillae of the cell wall are totally different from the usually accepted concepts of cell formation. In fact, despite such work as that of Freundlich and Kroch,[50] which showed that, under definite conditions in a sol, fairly large coagulated anisotropic particles might occur by mechanical influence, and that such mechanical coagulations appeared to be oriented, grave misgivings about accepting this new theory are entertained. For it must be remembered that there is a tendency, in any dissolving and swelling medium, for the tension effects existing between the solution and cellulose to draw the latter up into little mounds, especially when it is in a plastic state. Further, such interfacial tension, if in effect, would cause the formation of spherical or ellipsoidal figures similar in shape to those reported. And, finally, that in any microscopical investigation dealing with objects of such small size, all equipment must be designed and set up under strictly critical conditions; for the use of too brilliant illuminants, over-powered oculars, and/or high dry objectives, readily lend themselves to misleading optical effects.

Peirce [37] has put forward an hypothesis on the mechanism of growth which is of much interest.* He divides the growth history of the hair into three definite stages: (1) the formation of the cell in the epidermis of the ovule; (2) the period of length growth or outward extension; (3) the deposition of secondary thickening. In connection with this the complete reaction of deposition of a molecule of the soluble carbohydrate to the state of structured cellulose involves linkage formations in three directions: (A) along the spirilla; (B) transversely between spirillae in a cylindrical sheet; (C) radially between concentric layers. In the third stage all three linkage formations are active; in the second stage the first two; and in the first stage only the first. Each action corresponds to a stage in the physiology of the plant and probably to a different chemical state of the cell contents.

In the first stage the elementary filaments form and grow one-molecule thick without the power to cohere rigidly (possibly because of solvation or hydration of the hydroxyls). The beginning of coagulation of gelatine and other colloids *in vitro* is probably similar, but in that case the favorable conditions for coagulation prevail throughout the solution and the filaments

* The following paragraphs are a slightly condensed portion of his paper and may be taken as reflecting the current views on this subject of the British Cotton Industry Research Association.

grow at random in a network. In the primary deposition on a cell cuticle, the coagulation is highly localized and probably controlled by protoplasmic streaming which will most naturally close-pack the filaments with tangential orientation. Regarded as a continuous line, they thus form an irregular spiral with random reversals.

After flowering, and particularly on fertilization of the ovule, the growth of the latter is stimulated, accompanied by an increase in osmotic pressure which forces the spiral outward. Here the second linkage "B" comes into effect and the original spiral is reproduced by deposition in other spirals, one after the other, in the same surface. It is a process of intussusception which is in good accord with botanical theory, and its implications check with the findings of other workers.[38, 10]

On the commencement of secondary thickening the third force "C" becomes active, reproducing each spiral of the primary wall by apposition so that consecutive layers are built up centripetally until the central channel is nearly obliterated. The growth sequence, from point to line, to surface, to solid, is self-reproducing and preformed under the three conceivable growth methods: linear addition, intussusception and apposition.

Intermicellar Matrix.—Quite recently considerable attention has been directed to the intermicellar substance existing in the cotton cell wall. The hydroscopic nature of textile fibres, and cotton in particular, is well known, and the amount of moisture * that this fibre can absorb between the micellae is remarkable. In the main such action can be divided into three stages: (1) chemical hydration; (2) micellar adsorption; and (3) capillary association; but according to Astbury [51] the predominant part takes place as a condensation on the surface of the crystals. Further evidence lends strong support to the occurrence of intermicellar layers of other substances, either amorphous or crystalline; in fact, according to R. O. Herzog amorphous † cellulose does occur in these spaces, while Van Iterson proposes the possibility of an amorphous silicic ester of cellulose, pectinic substances, and deposits of lignin, suberin and soluble and insoluble phosphatids. Under such conditions it may of course be necessary to modify the more rigid views of cellulose structure and to assume for some of these substances a true chemical union with the micellar molecules. This, however, could take place without any alteration of the basic micellar arrangement and direction.

Nevertheless, such suppositions in themselves are not sufficient to explain all the phenomena exhibited by the cell wall. It seems necessary, therefore, to return to a consideration in more complex form of O'Neill's [52] original conclusions that the fibrillae themselves are fairly inactive but are embedded in a matrix (probably cellulose) which is soluble and readily reactive; a contention tending to be borne out by the present research.‡ This leads directly to a detailed examination of the intermicellar spaces and the substances occupying them (a topic outside the strict scope of this paper) but which will be briefly mentioned.

First, quite recently the meaning of dichroism with stained fibres has been made clearer [53] and can be well observed in fibres treated with chlorzinc-iodide solution, and even better in those treated with gold or silver.[54]

* Absorbed liquids also make the diffusion of dissolved substances through the cell wall possible.

† In the older concept of the word.

‡ See Fig. 17 where the fibrils are clear and definite and have resisted considerable mechanical mistreatment after soaking in sulphuric acid and iodine, in which the binding medium soon perished.

X-rays show that, in the latter instance, the metal particles are deposited in a submicroscopic crystalline manner as cubic isotropic crystals, but they are not all oriented in one crystallographic direction, being deposited irregularly in the intermicellar spaces.

Further evidence that the chlor-zinc-iodide is an adsorption reaction, and that the iodine permeates the intermicellar substance, is given by the reaction of certain conditioned fibres in this reagent. Thus, if damaged Manila is so treated, the fibre will take on throughout, and hold for a considerable period, a clear yellow color,—showing that the solution enters the intermicellar spaces; but if pressure is applied to any localized portion of the specimen, that spot and its immediate area turn blue. The assumption that the crystallites (due to the damage) are forced out from the intermicellar substance is not a sufficient explanation to account for this response. Robinson,[55] in fact, has observed the occurrence of a somewhat similar reaction in wood cells, which took place even before any mechanical deformation became evident.

There seems no doubt, therefore, that adsorption on to the crystal surface plays an important part. Recent work by Hardy [56, 57] and others [58] shows that layers of definite substances, one or more molecules thick, may occur on the surface of the micelles, and that these definitely influence the character of the subject. In substantiation Van Iterson [57] cites the case of Wislicensus' aluminum hydroxide fibres which are formed from amorphous particles, but which, on treatment with solutions of fat-like substances with subsequent evaporation of the solvent, show a radical change in "stabehen" double refraction [59] from positive to negative. The explanation of this change is that there is a deposit in definite position or arrangement of submicroscopic anisotropic fat particles in the intermicellar spaces, which, by their own double refraction, alter the sign of the fibre—which alone and untreated is positive.

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Special Librarians' Convention

THE Special Libraries Association will hold its 27th annual convention in Boston June 11th–14th with headquarters at Hotel Statler. This live and rapidly growing organization has now a membership of over 1600 trained librarians who manage the libraries of industrial concerns, research laboratories, museums, scientific, and other societies, as well as the specialized departments in large public and university libraries—in fact, any library devoted to one special field. The importance of trained library service to such special groups is now widely recognized and the Special Libraries Association devotes itself actively to the improvement of the methods and quality of such service.

The program of the coming meeting includes visits to the special libraries of Harvard University, Massachusetts Institute of Technology, and other special libraries in the Boston area, besides three general sessions and a large number of group and section meetings. The Science-Technology Group, which, with a membership of over 200, is one of the most active and alert, will hold three meetings. The Boston chapter of Special Libraries Association is the second largest in the association, having a membership of over 250.

A Critical Study of Cotton Manufacturing Processes

A Study of Methods of Measuring the Irregularity of Cotton Sliver

By R. L. LEE, Jr.*

Introduction

IN the course of investigations [1] into the irregularity of cotton strands, it became apparent that the use of the weights of different lengths as a basis for determining irregularity produced varying results and trends. This led to this wider study which makes use of various lengths of the slivers, and a sliver tester for determining the profile irregularity of slivers. Slivers from three cotton manufacturing processes, the card, first drawing, and second drawing, were sampled and analyzed for irregularity by two methods on several bases as follows:

1. Weight method, using
   (*a*) 1⅛ in. lengths
   (*b*) 6 in. lengths
   (*c*) 36 in. lengths
2. Sliver tester method, using autographic charts evaluated by
   (*a*) Manufacturer's method
   (*b*) Thickness readings at ¼ in. intervals on the charts
   (*c*) Use of the planimeter

Conclusions

Since, by the planimeter method, every variation in sliver thickness as recorded on the charts affects the result, it is logical to think that the planimeter measurements give a truer measure of the profile variation than any of the other methods.

As the lengths of samples by the weight method are shortened the results approach more closely the planimeter results.

Therefore, it is concluded that

(1) Correct trends and values for the profile irregularity of sliver are best shown by sliver tester charts, evaluated by either the planimeter method or by proper number of thickness readings taken at suitable intervals.

(2) The weights of sufficient 1⅛-in. or shorter lengths give results substantially the same as, and equally significant with, those obtained from the sliver tester charts, and in approximately the same time.

(3) For comparative tests any method will do.

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Excerpts from Literature on Previous Studies

Turner,[2] in a discussion of the general irregularity throughout the cotton yarn manufacturing processes, has used the weight method to give some idea of the degree of irregularity. The following tabulation of results is arranged from his report:

IRREGULARITY OF MATERIAL AT VARIOUS STAGES

	Scutcher	Card	Drawing Sliver		
	Lap	Sliver	1st	2nd	3rd
Irregularity (%)	3.01	3.80	4.68	1.95	2.28
No. of lengths tested	50	636	96	108	108

"The figures in this table relate to one-yard lengths except for the scutcher lap; if the weighings in all cases had been made on 6-in. lengths or less it is certain that the variation would have been still greater."

Laetsch [3] presents some figures of irregularity showing percentages based on the weights of 50 mm. lengths (approximately 2-in.) secured in the manufacturing of 42s warp yarn from an "American mix." The results are given for before and after the application of a twist testing-method in studying the performance of the machines.

VARIATION OF SLIVER THICKNESS EXPRESSED IN PER CENT BEFORE AND AFTER APPLICATION OF TWIST TESTING

Material	Before	After
Card sliver	7.4	5.9
First drawing sliver	12.1	8.36
Second drawing sliver	15.9	8.3
Third drawing sliver	19.0	8.5

Lipowsky [4] has written that all investigations of the uniformity of slivers and rovings have to cover two points: first, with respect to the investigation of short lengths (profile), and second, with respect to the investigation of long lengths (number uniformity).

Lipowsky has also outlined several methods of determining irregularity of sliver or roving. A summary of the outline follows:

Methods:

1. Visual judgment.
2. Weighing method.
3. Thickness measurements:
   (*a*) Twice, at right angles, between glass covers.
   (*b*) Between wheels that compress the sliver fibres together in the direction of pressure, but allow no side movement.
4. Additional twisting with
   (*a*) Subsequent breaking.
   (*b*) Doubling, using visual judgment.
5. Intermittent or continuous thickness measurement of twisted sliver by instrument of his design, in which

(*a*) The sliver is twisted and turned during calipering.
(*b*) There is axial displacement of the sliver for continuous operation or axial displacement of the measuring device.
(*c*) Evaluation of graphical results may be made in different ways, but no specific method is offered.

Balls [5] has written that "Given good preparation we may regard the finishing draw-frame sliver as being practically homogeneous, so that if it is cut up into short lengths it will show no appreciable variation of weight which is not covered by the experimental errors of such cutting."

Also [6] "The finishing draw-frame sliver is the natural starting-point for investigations on drafting because of its uniformity."

Experimental

Two 35-pound laps of oil-treated, $1\frac{1}{16}$-in., Delta, strict middling and middling mixed cotton, produced by a single-process picker, were secured from a manufacturing plant.

Manufacturing Conditions:—The cotton from the two laps was passed separately through the same card, first drawing frame, and second drawing frame under the same conditions of normal speeds and normal settings. Slight differences in drafts were necessary because of the difference in the average weight of yard lengths of card sliver. Designations as Test 1 and Test 2 were used throughout the study for the material from the respective laps.

Humidity Conditions:—All the manufacturing operations were carried out in an atmosphere of 53% relative humidity controlled by an automatic regulator. All the testing was performed in an automatically controlled moisture condition of 65% relative humidity. The temperature was not controlled, but no work was done under extreme conditions.

Sampling Procedure

The card sliver for each test was arbitrarily divided approximately equally among six sliver cans and designated as Slivers 1 to 6 respectively. As the card slivers were being fed to the first drawing frame, four random samples consisting of several layers of the coiled sliver were removed from each can, tagged to show test, can, and spot number, and then stored for irregularity measurements later. This method of sampling is shown diagrammatically in Fig. 1.

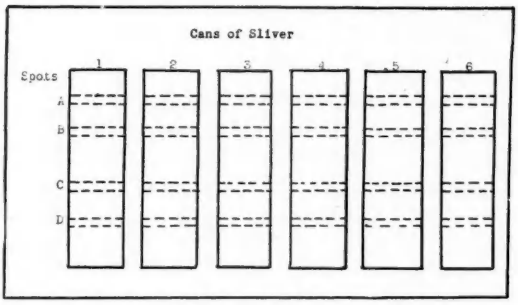

FIG. 1. Stratified sampling of sliver in cans.

As the sliver produced from the first drawing frame was fed to the second drawing frame, it was divided, sampled, and the samples tagged and stored in a manner similar to the method used for the card sliver. The sliver produced from the second drawing frame was sampled as it was being coiled into the can at delivery. Here, also, samples consisting of several layers of the coiled sliver were removed at 24 random spots, tagged, and stored for later use. Thus samples of the material from each of the three machines were secured from 24 spots.

From each sample, specimens were taken as follows: for weight determinations, 1⅛-in. lengths, 6-in. lengths, 36-in. lengths; and 20-yard lengths for passage through the sliver tester. The 36-in. lengths were taken from the material passed through the sliver tester.

Folding wooden templates were used as measuring devices for cutting the sliver into the desired lengths. In each instance the length of the template was ⅛-in. less than the cut length, to allow for the thickness of the scissors blade.

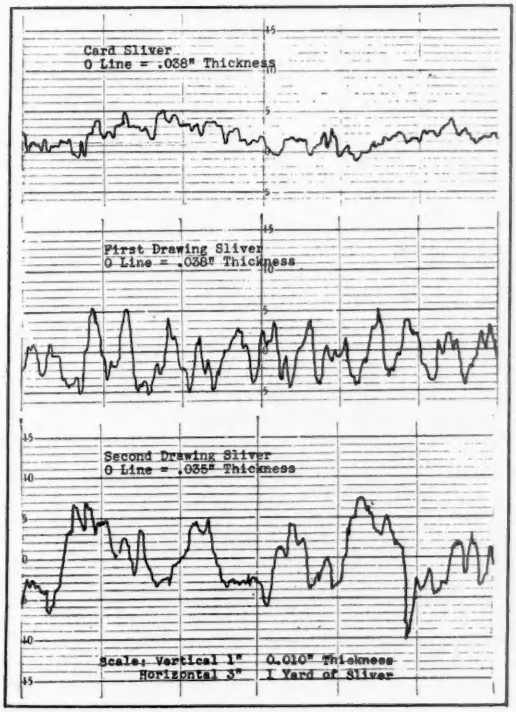
Card Sliver
0 Line = .038" Thickness
First Drawing Sliver
0 Line = .038" Thickness
Second Drawing Sliver
0 Line = .035" Thickness
Scale: Vertical 1" 0.010" Thickness
Horizontal 3" 1 Yard of Sliver

FIG. 2. Thickness charts by the evenness tester.

TABLE 1

Summary of Sampling of Sliver

Columns (Titles below)	1	2	3	4	5	6	7
1. WEIGHT METHOD							
(*a*) 1⅛-in. lengths.							
Card	24	20			80	480	15
First drawing	24	10			40	240	7.5
Second drawing	24	10			—	240	7.5
(*b*) 6-in. lengths.							
Card	24	20			80	480	80
First drawing	24	10			40	240	40
Second drawing	24	10			—	240	40
(*c*) 36-in. lengths.							
Card	24	20			40	240	240
First drawing	24	10			40	240	240
Second drawing	24	10			40	240	240
2. SLIVER TESTER METHOD							
(*a*) Manufacturer's evaluation method.							
Card	12	1	20	20	2	240	240
First drawing	12	1	20	20	2	240	240
Second drawing	12	1	20	20	2	240	240
(*b*) Thickness readings at ¼-in. intervals on charts.							
Card	12	1	6⅔	80	2	960	80
First drawing	12	1	3⅓	40	2	480	40
Second drawing	12	1	3⅓	40	2	480	40
(*c*) Use of the planimeter.							
Card	12	1	6⅔		2	24	80
First drawing	12	1	3⅓		2	24	40
Second drawing	12	1	3⅓		2	24	40

1. Number of samples.
2. Number of specimens from each sample.
3. Number of yards of material represented on chart of each sample.
4. Number of readings from each chart.
5. Number of specimens from each sliver.
6. Total number of specimens or readings.
7. Total number of yards of material measured in the result.

All the specimens of one length were cut successively with approximately one inch of discarded material between each specimen.

The 1⅛-in. lengths were weighed to the nearest 0.0001 gram, the 6-in. lengths to the nearest 0.001 gram, and the 36-in. lengths to the nearest 0.1 gram.

The sliver tester was used to secure autographic thickness charts, samples of which are shown in Fig. 2. In the sliver tester the sliver is subjected to a definite constant pressure (approximately 1600 pounds to the square inch) as it passes between two wheels. The top wheel of the two fits into a relatively narrow square-cut groove in the lower wheel, so there is no sidewise movement of the sliver. The thickness of the sliver is recorded on a special graph paper

through a system of levers, a gear, and a rack. On this record three inches horizontally corresponds to a sliver length of one yard; one inch vertically to a variation of sliver thickness of 0.010 in.

The same charts were used for the thickness readings and the planimeter measurements, and were taken from the charts for 20-yards used in the manufacturer's evaluation method.

The number of samples, specimens from each sample, specimens from each sliver, total specimens for each process, and yards of material in the total specimens for each process are summarized in Table 1 for each method of analysis. The sampling was identical for Test 1 and Test 2.

Irregularity Analyses

Differences in the character of the data necessitated different methods of analysis as follows:

Weight Method. From frequency distributions of the weights of the specimens, the mean, standard deviation, and coefficient of variation were calculated for each group of specimens. The coefficient of variation is taken as the measure of irregularity.

Sliver Tester Method. (1) Manufacturer's method: The maximum variation of thickness, in chart-units representing thousandths of an inch, was recorded for each yard of the 20-yards of sliver represented on the chart for each sample. The average of these 20 determinations was divided by the

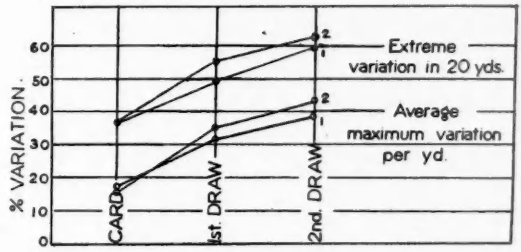

FIG. 3.

value of the zero line on the chart, as set by the operator's visual judgment after a trial run, and expressed as a percentage. The average of these percentages for the 12 samples was taken as the maximum variation value for a material.

The percentage of the extreme variation over each 20-yard chart was also computed. The average for the 12 charts of a material was taken as the extreme variation value for the material.

(2) Thickness readings at ¼-in. intervals on the charts: Readings of the thickness, expressed in thousandths of an inch, were taken at ¼-in. intervals on the charts. From a frequency distribution of the readings, the mean, standard deviation, and coefficient of variation were calculated for the group of charts for each process as a whole.

(3) Use of the planimeter: The area under the graph on the chart was measured with a planimeter; the mean line for the height of the graph from

the zero thickness was then computed and a line drawn on the chart to represent the mean line. The area enclosed by the graph above and below the mean line was next planimetered. The coefficient of variation was computed from these measurements as follows: [7]

$$\frac{\text{Sum of enclosed areas above and below the mean line}}{\text{Area under the graph adjusted to zero thickness}} \times 125.$$

These methods of analysis gave seven sets of values indicating the irregularity of the card, first drawing, and second drawing sliver for each test. These results are shown graphically in Fig. 3.

Significant Differences

Significant differences between coefficients of variation are considered as those equal to at least three-times the standard error of the difference.[8] The value for the ratio is designated as the "significance ratio." For a sample of 30 or more with a significance ratio of three, the chances are about one in 370 that the result is further off than its standard error. Thus it is fairly safe to regard such differences as being due to some other cause than that of being the unusual sample.

Significance ratios are shown in Table 2 for certain comparisons of methods of irregularity analysis. Significance ratios for the differences between all the cases or methods cannot be presented, since some methods of analysis do not yield a value for the standard error of the coefficient of variation; for instance, the values for irregularity from planimeter measurements.

TABLE 2

Significance Ratios

For Difference Between Coefficients of Variation of	Sliver, Test 1			Sliver, Test 2		
	Card	Drawing		Card	Drawing	
		1st	2nd		1st	2nd
Weight Method						
6-in. and 36-in. lengths	1.2	5.8	13.7	−2.1	7.5	13.9
1⅛-in. and 36-in. lengths	3.4	11.5	17.4	1.6	14.2	17.4
1⅛-in. and 6-in. lengths	2.6	7.0	8.2	4.3	9.3	7.2
Thickness Readings and Weight Method						
¼-in. readings and 1⅛-in. lengths	2.6	1.9	2.8	−1.1	2.9	1.9
¼-in. readings and 6-in. lengths	5.7	10.9	13.2	4.3	14.5	10.7
¼-in. readings and 36-in. lengths	6.0	16.8	25.1	0.9	21.1	24.4

− sign indicates that the second-mentioned length or sample had the larger coefficient of variation.

Discussion

It may be seen from the graphs in Figs. 3 and 4 that for the weight method of determining the irregularity, the coefficient of variation is greater for the shorter lengths than for the longer lengths, with only one exception in 18 cases. The exception is in the case of 36-in. lengths of card sliver for Test 2, which has a larger coefficient of variation than the 6-in. lengths of the same material. Further, the variation as indicated from the sliver tester charts is higher than that shown by the weight method, with only one exception. This is in the case of 1⅛-in. lengths of card sliver for Test 2, which has a larger coefficient of variation than that for the ¼-in. readings. The method of evaluation of the charts advocated by the sliver-tester manufacturer produces much higher values than the other methods.

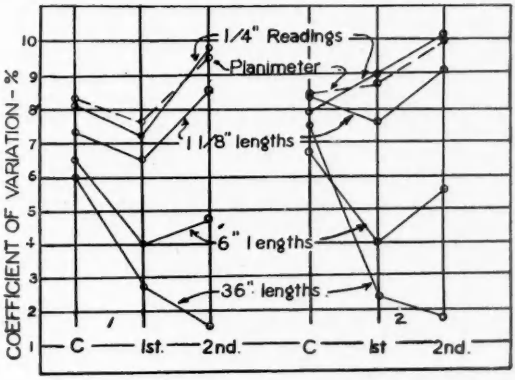

FIG. 4.

The values from the planimeter measurements and thickness readings are in close agreement. The values from the planimeter measurements and the weights of 1⅛-in. lengths are in fairly close relation, except for the case of either the card sliver or first drawing sliver for Test 2. If the relative values shown for Test 1 are taken as a probable standard, then the value for the card sliver of Test 2 by the planimeter method is too low, or the value for the first drawing sliver is too high.

It may be noticed that, for all the methods of irregularity analysis, the values for the card sliver are somewhat closely grouped together, with the values for the first drawing sliver becoming divergent, and the values for the second drawing even more so.

The trend of irregularity through the three processes (card, first drawing, and second drawing) is indicated as follows by the different methods of analysis:

Thirty-six-inch lengths indicate an improvement in uniformity through each successive process.

Six-inch lengths indicate an improvement in uniformity through the first drawing and an increase in irregularity through the second drawing.

Lengths of 1⅛-in. indicate an improvement in uniformity through the first drawing and an increase in irregularity through the second drawing, with a final coefficient of variation greater than that for the card sliver from which it is made.

The planimeter measurements of the sliver-tester charts show a varying, but not great, change through the first drawing and an increase in irregularity through the second drawing.

Thickness readings from the sliver-tester charts indicate the same trends generally as the planimeter measurements.

The sliver-tester manufacturer's method indicates a substantial increase in irregularity through both the first and second drawing processes.

The comparability of results, the significance of differences in coefficients of variation, the experimental errors, and the time element should be considered.

In Table 1 it may be noticed that the results from the several methods of analysis are comparable in most cases, either on the basis of equal amounts of material or equal numbers of observations or readings.

The results from the weights of 6-in. lengths, the planimeter measurements of sliver-tester charts, and the thickness readings from the same sliver-tester charts are comparable on the basis that they represent analyses of equal amounts of material.

The results from the weight method for the three lengths are comparable on the basis of equal number of specimens, with the exception of card sliver for 36-in. lengths which has only one-half as many specimens as the card sliver of the other two lengths, but includes a much greater yardage of material than the other two lengths.

In preliminary studies it was found that card sliver appeared to be so variable, especially in the mean weight from one spot to another, that more specimens were thought to be necessary to secure a representative sample of the whole mass of card sliver than for either first or second drawing. For this reason the number of card sliver specimens was doubled for 1⅛-in. and 6-in. lengths.

Differences between the coefficients of variation for one length of card sliver and that of another length are not significant except in two out of six instances. It might be expected that, if a significant difference exists, it would be between the coefficients of variation for the shortest and the longest lengths. This is true for Test 1, but is not true for Test 2 because of the relatively high variability of the 36-in. lengths. In Test 2 it is the difference between the coefficients of variation of the 1⅛-in. and the 6-in. lengths which is significant.

For the first drawing and second drawing sliver the difference between the coefficients of variation for the various lengths are all significant.

Differences between the coefficients of variation based on thickness readings, and those based on the weights of specific lengths of sliver, are not significant when the length is 1⅛-in.; they are significant when the length is 6-in., and even more so for 36-in. lengths, except for one instance.

It may be seen from Fig. 4 that the coefficients of variation for the thickness readings are in close agreement with the coefficients derived from the planimeter measurements of the same charts. Since the difference between the coefficients of variation for the thickness readings and those for the 1⅛-in. lengths are not significant, it may be safe to assume that the differences between the planimeter measurement results and the 1⅛-in. length results are not significant.

Experimental Errors

Weight Method. Regardless of the length being cut, check measurements indicated that the maximum variation in the lengths from the same template was not greater than $\frac{1}{16}$-in. This is an extreme variation of 5.55% for $1\frac{1}{8}$-in. lengths, 1.04% for 6-in. lengths, and 0.173% for 36-in. lengths. If the average error is $\frac{1}{32}$-in., its effect would be 2.78% for $1\frac{1}{8}$-in. lengths, 0.52% for 6-in. lengths, and 0.087% for 36-in. lengths.

Sliver Tester Method. Two different Venturi pens were used on the sliver tester in producing the charts. One pen was used for the charts of card sliver in Test 2; the other pen for all the other charts. It was found that the pens did not record at exactly the same level under the same conditions. The difference corresponded to 0.001-in. or 0.0015-in. of sliver thickness, or a maximum percentage error of 4.57% when based upon a minimum sliver thickness of 0.033-in. This may account for the apparent inconsistency of the coefficients of variation from the charts for the card sliver of Tests 1 and 2.

The thickness indicator on the sliver tester was not calibrated.

Any error in the planimeter and its use affects the results. Ordinarily this is considered to be approximately 2%. Every measurement by the planimeter was made twice, and, if a marked difference was observed, measured a third time.

Time Element

The time necessary in cutting specimens is about the same for each of the different lengths used.

The time necessary for weighing the specimens is about the same for each of the lengths. The longer time consumed in securing a finer balance of the scales for the shorter lengths is fully compensated for by the ease of placing the shorter lengths on the pan of the scales, and by the fewer changes of scale pan weights necessary. With a chainomatic balance, the shorter lengths probably require somewhat less time for weighing.

The preparation of the sliver-tester charts consumes considerable time.

Evaluation of sliver-tester charts by the manufacturer's method is very rapid. Thickness reading evaluation of the sliver-tester charts is fairly rapid. Planimeter measurements are much slower than the thickness reading method. If all the charts for the various samples were prepared with the same zero line setting of the sliver tester, evaluation by either method would be expedited.

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ing Sliver and Their Testing.) Translation by H. P. Gurney. *Textilber.*, *14*, 332-35 (1933).

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6. *Ibid.*, P. 126.

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Meeting of Southern Members

The first meeting of U. S. Institute for Textile Research, Inc., in the South was held at the Poinsett Hotel, Greenville, S. C., Thursday, April 11th. In attendance were 37 members, including several from the North who were in Greenville for the Textile Exposition, held there that week. Jno. W. Arrington, president of Union Bleachery, Greenville, S. C., and a director of U. S. Institute, had charge of arrangements and presided at the meeting following luncheon. He had with him as guests 10 leading manufacturers of Greenville and vicinity.

Secretary Clark and Dr. H. DeW. Smith, vice-chairman of the Research Council, reported on the progress of Institute work, with particular reference to the organization and present status of the warp sizing research.

The question of organizing a southern section of U. S. Institute was discussed by Mr. Arrington, Prof. Willis and others, but it was the consensus of opinion that this was unnecessary at present, although it might be advisable to hold conferences in the South for the consideration of new research subjects, similar to that held in New York City in May, 1934, which resulted in the present warp sizing project.

Following the Greenville meeting Secretary Clark spent two weeks among southern mills visiting present and prospective members, and attending the convention of the American Cotton Manufacturers Association in Augusta, Ga., April 25th and 26th.

Top-Quality Determinations:

Note on Proposed Comparison Specifications for

By E. O. KRUEGEL *

DURING the past few months many controversies have come up as to the interpretation of wool quality measurements by the so-called wedge method. The reason for these disagreements has been that no two observers agree *exactly* as to diameter or frequency distribution.

It must first of all be realized that in any investigation repeated measurements do not agree *exactly*. The cause of these discrepancies lies in the various sources of error to which all data are subject. This does not warrant, however, the conclusion that the data is unreliable and should be discarded.

In any investigation it is first necessary to eliminate, or correct for, all the controllable errors. These include errors due to instrumentation and sampling technique. Next come the so-called personal equation errors. While these errors cannot be entirely eliminated, they can be reduced by well trained observers, so that all the results will fall within a limited range.

It is with this in mind that the following limits of agreement for the various top qualities have been proposed:

Specifications

(1) All projection machines are to be set so that the micron divisions on the stage micrometer correspond to the sample wedge, Fig. 1 (magnification approximately 300 ×).

(*a*) *Explanation.*—From an optical point of view the extreme practical limit of magnification of an instrument of this type is 500 ×. Experience has shown, however, that at this magnification (using an 8 mm. objective and a 12.5 × ocular) the diffraction band effect cannot be eliminated. Various lower magnifications have been tried and 300 × was found to be the magnification best suited for wool quality determinations using the above mentioned lens system. Higher magnification is obtainable without diffraction band effect if an objective of higher numerical apperture is used. This would have to be a 4 mm. lens. While 500 × would then be allowable, the depth of focus would be so reduced as to make the investigation difficult, particularly when

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traversing a fibre. Since the working distance is also very small, difficulty will be experienced in avoiding damage to the slide and objective.

(2) Any quality cannot be subdivided into more than three main grades: Good, Average, Poor.

(*b*) *Explanation.*—Since it is impossible to differentiate one grade of top from another closer by eye than as mentioned, due to the present-day method of sorting, it seems unwarranted to carry wool quality determinations by the wedge method to any greater degree of precision.

(3) Each grade within a quality will have a definite diameter range determined from the examination of tops over a period of not less than three years. Also the standard average value, with its deviation from that value, shall be

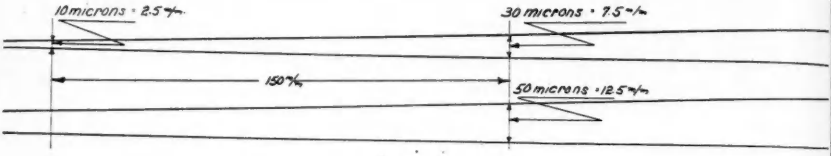

FIG. 1.

determined from no less than 4000 fibres taken at random from no less than 40 tops over the period mentioned.

Example: 64s Quality

Good	Average	Poor
20.9–21.3	21.4–21.8	21.9–22.3

Therefore, if the average of any series of observations falls between 20.1 and 20.5 microns it shall be considered a good top, etc.

(4) The range of acceptance of *any* top shall be the average of two or more different observers ± 0.3 micron.

(*c*) *Explanation.*—The factor ± 0.3 is a probability factor based on the least number of fibres required to give consistent limit ranges and is the same for all top qualities.

Example

Observer No. 1 aver. = 20.6 μ
No. 2 aver. = 20.9 μ

Aver. 20.75 μ

Range = 20.45–21.05 microns.

The average value of both observers falls within the range so that the results will be considered identical.

Case II

Suppose observer No. 1 aver. = 20.0 μ
No. 2 aver. = 21.0 μ

Aver. 20.5 μ

Range = 20.2–20.8 microns.

Neither observer falls within the limiting range. This discrepancy may be caused by one of two things:

(*a*) Samples of top not the same
(*b*) Observers in error

To find whether (*a*) or (*b*) applies:

(1) Have observer No. 1 analyze sample No. 2
(2) Have observer No. 2 analyze sample No. 1

If the results now are:

Observer No. 1 = 21.0 μ
No. 2 = 20.0 μ } The samples are different.

If the results now are:

Observer No. 1 = 21.0 μ
No. 2 = 20.8 μ } Observer No. 2 is in error.

(5) The minimum number of fibres required for each quality for comparison with other observers shall be:

80s, 70s: 200 fibres	64s, 62s: 300 fibres	60s, 58s: 400 fibres
56s, 50s: 500 fibres	48s, 46s: 600 fibres	Lower than 46s: 800 fibres.

Directors of Warp Sizing Research

(*Continued from page 306*)

used in warp sizing, and of completed research in sizing is a necessary approach to the planning of the initial basic research program. Much of the data for this survey has been covered by Dr. Katz in his various prior publications, and he is now preparing a complete summary; this will be the first of the series of warp sizing reports. He will then complete the program for new basic research. Mr. Yelland will start his work May 1.

Dr. Katz presented a paper on the X-ray Spectrography of Starch at the symposium on starch that was one of the features of the tercentenary celebration of the American Chemical Society in New York City the week of April 22.

Comments on Lee's Study of Cotton Spinning Irregularities

By CHARLES H. CLARK *

IT was the principle of drafting by means of two pairs or rolls, originally discovered by Wyatt in 1730, patented by Paul in 1738, and developed on a commercial basis by Arkwright in 1775, that was chiefly responsible for machine spinning superseding hand spinning.

And now an investigation conducted by R. L. Lee, Jr., at the Lowell (Mass.) Textile School under the direction of Prof. H. J. Ball, and financed by the Textile Foundation,[1] has demonstrated scientifically that the drafting process is responsible for more irregularity in roving and yarn than any other process. His study has proved that the irregularity of the product of roving and spinning frames is greater than that of the first- and second-drawing frames, and that this irregularity is due principally to the drafting process.

Possibly Wyatt, Paul and Arkwright were aware of this short-coming, but there is no record that they were. They sought a system of machines that would produce a commercially satisfactory yarn of a certain count from an initial mass of cotton. They succeeded to the extent that they were able to approximate the desired count of yarn by a succession of reducing processes. These basic principles of cotton spinning are unchanged today. As then, doublings, which rely for desired results upon the law of averages, are chiefly depended upon to reduce the irregularities in roving and yarn due to "uncontrolled" drafting.

"Uncontrolled" Drafting

By "uncontrolled" drafting we refer to the inability of the process to select and place parallel to the axis of the roving or yarn approximately the same number of fibres in each cross-section. That is a yarn that is approximately even and strong throughout its length when spun from "even running" cotton of good character. Apparently cotton technicians abandoned long ago the hope of producing such an ideal yarn by machinery. At least there are few records of such efforts. So-called high-drafting was not invented for that purpose, although sometimes incorrectly referred to as "controlled" drafting. Its basic purpose was and is to draft cottons of varying lengths with a minimum of cockling and waste. Lee in his report shows that the irregularity of yarn produced with high-drafting is somewhat greater than that from regular drafting.

Controlled Drafting

There was, however, a hand-spinning process that involved a method that might be correctly termed controlled drafting, in that its purpose was

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to produce a yarn having the same number of fibres in each cross-section. It was practiced by hand-spinners of flax, and may have been the way by which Hindu spinners are credited with having spun cotton yarns of 500s count. Moving pictures of this process are on display in the Museum of Science and Industry, New York City. The spinster not only allows the twist to run into the mass of flax and draw out the fibres, but she also draws back by hand those fibres that are not needed to produce a yarn of the desired count. The thousands of machine inventors who have sought to improve the basic processes since the "industrial revolution" have never been able to duplicate this essential feature of refined hand spinning.

The Important Results of Lee's Work

The results of Lee's work[1] are in large part confirmatory of those of W. Lawrence Balls,[2] excepting that the latter lists the product of the finishing drawing-frame as being superior in regularity to that of the first and second drawing-frames, as found by Lee. Balls' exhaustive study of drafting proved that it "was fundamentally responsible for the way in which actual yarn deviates from the cylindrical form of the ideal."

In his conclusions on the subject of drafting Balls expresses little hope that precise control of each individual cotton hair can be substituted for "the chance distributions given by Wyatt's rollers." He does, however, visualize hope for a more perfect yarn in the fact that "the spinner is already in possession of a sliver which is very near perfection, from the finishing draw-frame." Confirmation of this conclusion, with the exception noted, may be accepted as the most important result of Lee's work. That this is one of the most practical methods of decreasing the irregularities due to the drafting process has been realized for sometime by certain manufacturers and machinery firms, but progress in the elimination of drafting between the drawing and spinning frames has been confined thus far to a comparatively narrow range of coarse counts. The essential machinery for this system of drafting and spinning may soon be available, but the problem will never be satisfactorily solved along these lines until it is studied in conjunction with the cotton and the card sliver to be processed. We do not need the results of Balls' research work to know that "the principal responsibility for drafting defects has been traced to the cotton itself, putting the machines into their proper places as accessories." Any experienced cotton manufacturer also knows that the way to improve card sliver is to card light. Super-drafting on the drawing frames and the reduction of roving machinery will necessitate more cards and lighter carding, and more careful selection of good character cotton, that is "even-running" as to length and weight per unit length, if a yarn of improved evenness and strength is to be produced. A quantitative and qualitative study of the latter factors is a needed supplement to Lee's work.

References

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Abstracts and Bibliography

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwartz, Chairman, Dr. W. E. Emley, Prof. Louis A. Olney and M. W. Weiss.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Raw Materials for Rayon Manufacture: On the Synthesis of. (German.) Hans Lederer. *Die Kunstseide*, 1934, V. 16, P. 43–9.

Starting from glycols, dibasic acids, amino acids, and other simple compounds, Carother has succeeded in preparing synthetically open-chain polymers with a molecular weight of 3000. In the molecular still, these polymers may be transformed into superpolymers with a molecular weight of 10,000. From these superpolymers an excellent "synthetic silk" is readily obtained. (S)

Silk Weighted with Tanning Matter. Ernst Wulff. *Z. ges. Textil-Ind.*, 1934, V. 37, P. 527; *Chem. Abs.*, 1935, V. 29, Col. 349. (W)

Spinning of Viscous Rayon by the Stretch Method. (German.) J. Gruz and S. Rogovin. *Die Kunstseide*, 1934, V. 16, P. 263–6.

This is a contribution from the Research Institute for Rayon of Moscow. The author has studied the stretch spinning process for viscose by the Thiele process used for the spinning of cuprammonium. The article discusses the best value of viscosity, of maturation, and the composition of the viscose as well as the kind and composition of the precipitating bath. This particular spinning method permits obtaining fine filament rayon with increased strength. (S)

Swelling of Viscose Films and Methods of Increasing Their Resistance to Water. P. I. Vaskrisenski. *Photo-Kino Ind.*, 1934, No. 1, P. 81–6.

Of the possible methods of increasing the resistance of viscose films to water, the following four appear feasible and worth further detailed study: (1) Lacquering; (2) esterification so as to produce a monomolecular layer of cellulose ester; (3) additions to the viscose; and (4) parchmentizing of the finished film. (Copied complete from the *Eastman Kodak Abs. Bull.*, Nov. 1934, P. 393.) (S)

Textile Fibres in Thermal Insulation. Herman Boxser. *Am. Dye. Rptr.*, 1934, V. 23, P. 442–4.

The author notes that textile fibres have found an outlet for application in the field of thermal insulation in a number of different lines. With

the advent of air conditioning in homes, there is little doubt but what much further use will be found for textile fibres amongst the heat insulating bodies under development. Several tables and characteristics of various types of textile and other heat insulators are given some of the data from the Bureau of Standards. A brief discussion of heat insulation and its measurement is also included. (S)

VISCOSE RAYON: LIGHT-TRANSMISSIBILITY OF. N. Matsumoto. *J. Soc. Chem. Ind. Japan* 37, Suppl. binding, 1934, P. 356.

Various viscose rayons of the same fibre diameter and prepd. under the same spinning conditions, but with the H_2SO_4 content of the coagulating bath varying from 7.5 to 30% were examd. The transmissibility probably depends upon the dimensions of the cellulose micelles or their groups. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7003.) (W)

WASHING RAW WOOL IN ACID BATH: ADVANTAGES AND REALIZATION. J. Vallée. *Chim. & Ind.*, April, 1934, P. 854–7.

From a discussion of the nature of the impurities to be removed (sol. salts, soil, fatty substances) it is concluded that there is no reason why scouring in acid bath should not give good results. The following process is recommended: (1) Two baths of 0.2% H_2SO_4 at 30–40°; (2) two baths of 0.05–0.2% sulfonated lauryl alc. at not less than 55° (preferably about 60°); (3) final rinsing in a 0.05% sulfonated lauryl alc. contg. buffer salts to bring the pH to about 5 (isoelec. pt. of wool fibre). Existing equipment can be used provided it is coated with a protective varnish. The merits of the proposed process are outlined. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5991.) (W)

WEIGHTING SILK AND RAYON: IMPROVED METHODS OF. H. Roche. *Silk J.*, 1934, V. 11, No. 123, P. 16–17.

A general discussion. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7026.) (W)

WOOL: CHLORINATION AND DETERIORATION OF. O. Viertel. *Textil-Forsch.*, 1934, V. 16, P. 54–7; *Chim. & Ind.*, V. 32, P. 415–16.

A discussion of the beneficial and injurious effects of chlorination on wool. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7028.) (W)

WOOL: DAMAGES TO—CAUSED BY ACIDS. W. Fu. *Z. ges. Textil-Ind.*, 1933, V. 36, P. 48–9.

Expts. carried out to test the action of H_2O and of various concns. of H_2SO_4, AcOH and HCO_2H at boiling temp. for several hrs. showed that the addn. of as much as 12% H_2SO_4 still exerts a protective action, 6% H_2SO_4 maintains its protective action for nearly 5 hrs., 3% H_2SO_4 contributes little to any fibre damage, and intensive washing hardly removes half of the absorbed H_2SO_4. The rinsing may be omitted with baths contg. less Glauber salt. It is claimed that H_2SO_4 increases the light sensitivity of wool; such a tendency is decreased by the presence of the dye, which must be destroyed first before the fibre can be attacked. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7027.) (W)

II. Yarns and Fabrics

Defects in Crepe Fabrics. Harold De Witt Smith. *Am. Dye. Rptr.*, 1934, V. 23, P. 736–8.

A paper presented at the Annual Meeting of the A. A. T. C. C. in New York City, Dec. 7, 1934. A brief paper pointing out the fact that man made fibres are here to stay and that high quality in fabrics created with these fibres can be attained by proper control, and that if some fabrics can be made correctly, all can be made correctly if the control is rigid enough. (S)

Fallacy in Excess Worsted-Drawing Steps. Anon. *Tex. Wld.*, 1934, V. 84, P. 106.

A brief review of work done at the Lowell (Mass.) Textile Institute by John C. Lowe and certain students to show the effects of three different types of processing set-up on worsted yarn and fabric. The conclusions drawn are that excessive processing seems to affect the physical properties of the fibre thus reducing both the strength and elasticity of the yarn. In both experimental set-ups the ordinary yarn is inferior both in strength and elasticity. It is recommended that avoidance of an increase in weight reduced by doubling after leaving the Noble comb would reduce the number of operations necessary to produce a satisfactory yarn. (S)

Faults in Rayon Yarns and Fabrics: Quick Tests for Certain Properties and Causes of. Rayon Sub-Committee. *Rayon and Mell. Tex. Mo.*, 1934, V. 15, P. 58–9, 71.

This is a publication of the Rayon Sub-Committee of the A. A. T. C. C. and gives their approved technique for the removal of rayon from mixed fabrics, the microscopic identification of rayon in mixed materials, and the quick determination of completeness of desizing of acetate crepe fabric, quick determination of twist in combination acetate threads, short length denier determinations, quick cross-section determination of short lengths of yarn, and the knitting test for uniformity. (S)

Minus Colour in Textiles. J. M. Preston. *Tex. Mfr.*, 1934, V. 49, P. 286–7. (S)

Photomicrographs of Silk Show Differences Between Pure-Dyed and Weighted. Anon. *Tex. Wld.*, 1934, V. 84, P. 102.

Several photomicrographs are shown with a paragraph descriptive of the pictures. The evidence is not particularly impressive but indicates possibilities. (S)

Quality Rayon Fabrics: A Necessary Background for the Production of. J. B. Quig. *Am. Dye. Rptr.*, 1934, V. 23, P. 718–24, 733–4.

A paper presented at the Annual Meeting of the A. A. T. C. C. on December 7, 1934, in New York City. The article discusses at some length the moisture regain effects in rayon yarn, particularly as it may affect both stretch and strength. A great many of the references are from work done at Courtalds and other British laboratories. (S)

RAYON WARP SIZING. Hector C. Borghetty. *Tex. Wld.*, 1934, V. 84, P. 76–7.

An article which is an amplification of a paper presented for the conference on warp sizing held in May, 1934, by the United States Institute for Textile Research. The discussion includes material on the selection of sizing ingredients, proper drying temperature, warp tensions, and the effect of stretching. (S)

REGENERATED CELLULOSE FABRICS: CAUSES OF FAULTS ENCOUNTERED IN. Ernest H. Benzing. *Am. Dye. Rptr.*, 1934, V. 23, P. 734–6.

A paper presented at the Annual Meeting of the A. A. T. C. C. December 7, 1934, in New York City. The article treats of faults in fabrics which are handled on jig and pad and fabrics which are customarily handled on the winch. (S)

SHORT CUT TO TWIST. William N. Chace. *Tex. Wld.*, 1934, V. 84, P. 65–6.

A very brief discussion including a diagram showing a method of determining twist in single yarns. The principle is that a one-in. length of yarn is untwisted until it breaks under a given constant tension. A second one-in. length is inserted in the machine under the same tension conditions and is twisted up until it breaks. The mathematical treatment of these two magnitudes of twist is said to give an average value of twist per inch for the yarn. Details of the technique are indicated and it is said that yarns from a range of 12s to 150s including fibres from one inch to better than an inch and a quarter have been used. (S)

SILK AND RAYON PIECE-GOODS: SOME TECHNICAL CONSIDERATIONS OF THE PROBLEMS CONFRONTING THE MANUFACTURER. H. A. Mereness. *Tex. Col.*, 1934, V. 56, P. 515–8.

Suggestions are given for improving the quality of silk and rayon merchandise by the establishment of standard test methods and limits for such properties as shrinkage in laundering and color fastness to washing, perspiration and light. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7543.) (W)

SKEIN TEST: A DISCUSSION OF THE. J. L. Delany. *Cotton*, 1934, V. 98, P. 61–4.

An elementary but rather complete discussion of the usual skein test for the determination of the size of the yarn and the strength of the yarn together with the so-called skein-break factor. Reference is made to work done by Sheldon and Son and the American Society for Testing Materials. (S)

STREAKS, MARKS, AND OTHER FAULTS IN RAYON FABRICS. (German.) Johannes Schlechte. *Die Kunstseide*, 1934, V. 16, P. 238–9.

Streaks and marks are dangerous defects in rayon tissues. The manifold causes of these defects can only be understood by carefully examining all steps of the manufacturing process. A survey is given in this article. (S)

III. Chemical and Other Processing (Not Otherwise Classified)

Dyeing: Variations in Critical Mean Luminosity in. R. Toussaint. *Chimie & Ind.* Spec. No., April, 1934, P. 765–7; *Chem. Abs.*, 1934, V. 28, Col. 5988. (W)

Dyeing and Finishing of Cotton. F. Scholefield. *J. Soc. Dyers Col., Jubilee Issue* 1884–1934, P. 106–14; *Chem. Abs.*, 1934, V. 28, Col. 6314. (W)

Dyeing and Finishing of Rayon. Percy Bean. *Tex. Bull.*, 1934, V. 47, No. 1, P. 12–3, 18, 22.

Faults arise in dyeing processes from wrong manipulation, ill-chosen dyestuffs, faults caused by the yarn and by previous processes. The main trouble in dyeing is due to varying dyeing properties of warp and weft yarn, spinning variations, overstretching, and variation in cross-sectional shapes causing differences in dyeing affinity. Means and methods of re ducing the damage are given and tendering, "blinding," friction damage, delustering faults, damage in mercerizing, and dulling from filling material are discussed. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7539.) (W)

Dyeing Cellulose Acetate: Some Newer Methods of. Ludvík Spirk. *Textilní Obzor*, 1932, V. 28, P. 159; *Chem. Obzor*, V. 9, Abs. Sec., P. 232; *Chem. Abs.*, 1934, V. 28, Col. 6569. (W)

Dyeing Fibrous Materials: Process of. V. Interaction of Animal Tissues and Ammonia Solution. A. E. Porai-Koshitz. *J. Applied Chem.* (U. S. S. R.), 1934, V. 7, P. 99–102; *Chem. Abs.*, 1934, V. 28, Col. 7538. (W)

Dyeing Mixed Viscose-Acetate Fabrics in Blacks Fast to Washing. P. Barsy. *Russa*, 1934, V. 12, P. 577–81; *Chem. Abs.*, 1934, V. 28, Col. 7020. (W)

Dyeing of Mixed Textiles Containing Rayon with Particular Consideration of the Dyeing of Vistra-Wool Mixtures. R. Hünlich. *Monatsh. Seide Kunstseide*, 1934, V. 39, P. 337–40, 381–6; *Chem. Abs.*, 1934, V. 28, Col. 4238, 7020. (W)

Dyeing of Rayon. Georg Rudolph. *Kunstseide*, 1934, V. 16, P. 225–9; *Chem. Abs.*, 1934, V. 28, Col. 4237, 7018. (W)

Dyeing of Rayons. C. M. Whittaker. *J. Soc. Dyers Col., Jubilee Issue* 1884–1934, P. 127–33; *Chem. Abs.*, 1934, V. 28, Col. 6315. (W)

Dyeing of Rayon: Cause for the Change in Tint During the. Karl Lauer. *Monatschr. Textil-Ind.*, 1934, V. 49, P. 42, 65–8; *Chem. Abs.*, 1933, V. 27, P. 846; 1934, V. 28, Col. 7020. (W)

DYEING OF RAYONS IN MASS. Henry Dosne. *Bull. soc. ind. Mulhouse,* 1934, V. 100, P. 232–49.

Ester-salts of the leuco derivatives of certain vat colors are sol. in H_2O and stable to air, to alkalies and to some acids. A soln. of such an ester-salt (no examples given) is incorporated with the viscose mass before spinning. The threads are later subjected to the action of an oxidizing agent in acid soln., *e.g.*, H_2SO_4 plus $NaNO_2$, whereby the color is developed. Or, an oxidizing agent inactive in alk. soln., as $Al(ClO_3)_3$, may be added before spinning and the color developed by a subsequent acid bath. The shades so produced are bright, pure and uniform. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 5673.) (W)

DYEING PROCESS: EFFECT OF WATER CONTAINING SULFITE ON THE. Kurt Biltz. *Monatschr. Textil-Ind.*, 1934, V. 49, P. 185–6; *Chem. Abs.*, 1934, V. 28, Col. 7020. (W)

DYEING SILK WITH SUBSTANTIVE DYES, IN THE PRESENCE OF AMMONIUM CHLORIDE, AND THE SATURATION LIMIT OF SILK WITH THESE DYES. IV. A. E. Porai-Koshitz. *J. Applied Chem.* (U. S. S. R.), 1934, V. 7, P. 91–7; *Chem. Abs.*, V. 23, P. 4345; V. 28, Col. 330, 7539. (W)

DYEING VISCOSE WITHOUT PRELIMINARY DRYING. N. Malyutin, I. Kamushev and L. Meshalkina. *Iskusstvennoe-Volokno* (*Artificial Fibre*), 1934, V. 5, No. 3, P. 12–8; *Chem. Abs.*, 1934, V. 28, Col. 6316. (W)

DYEING WITH WILD FLOWERS. W. Furlonger. *Dyer,* 1934, V. 71, P. 617; *Chem. Abs.*, 1934, V. 28, Col. 5673. (W)

DYES: ANALYSIS OF INTERMEDIATE PRODUCTS IN THE SYNTHESIS OF THIOINDIGO. A. P. Ershov. *Anilin. Prom.*, 1934, V. 4, P. 303–5; *Chem. Abs.*, 1934, V. 28, Col. 7535. (W)

DYES: RELATION BETWEEN THE CONSTITUTION AND SUBSTANTIVITY OF. Paul Ruggli. *J. Soc. Dyers Col., Jubilee Issue* 1884–1934, P. 77–82; *Chem. Abs.*, 1934, V. 28, Col. 6314. (W)

DYES: RESISTANCE OF—TO ULTRA-VIOLET LIGHT AND A METHOD OF EXAMINATION. G. A. Bravo. *Industria chimica,* 1934, V. 9, P. 461–8; *Chem. Abs.*, 1934, V. 28, Col. 4238.

Measurements of the resistance of a no. of dyes to ultra-violet light are reported. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 6316.) (W)

DYES: SOME OUTSTANDING EVENTS AND METHODS IN THE COMMERCIAL APPLICATION OF—ON COTTON AND ALLIED FIBRES. Adolf Singer. *J. Soc. Dyers Col., Jubilee Issue* 1884–1934, P. 99–105; *Chem. Abs.*, 1934, V. 28, Col. 6314. (W)

DYESTUFFS: EFFECT OF DISPERSION AND SOLUBILITY OF—ON THE DYEING OF CELLULOSE ACETATE. J. Rolland. *Chim. & Ind.* Spec. No., April, 1934, P. 847–50; *Chem. Abs.*, 1934, V. 28, Col. 5989. (W)

IV. Research Methods and Apparatus

Rayons, Yarns and Fabrics: Quick Tests for Certain Properties and Causes of Faults in. *Tex. Bull.*, 1934, V. 47, No. 3, P. 10, 24–5; *Chem. Abs.*, 1934, V. 28, Col. 7542.

This is a report of the rayon sub-com. of the A. A. T. C. C. (W)

Sensitivity of Substantive Colors to Calcareous Water: Method for Determining. Henri Sunder. *Bull. soc. ind. Mulhouse*, 1934, V. 100, P. 365–71.

The test is made by dissolving 0.6 g. of color in 200 cc. of distd. H_2O, then pouring this soln. into 1 l. of the hard water. Dyes can thus be divided into three classes: (1) Those which form no ppt. on long standing and can be safely used; (2) those which show a turbidity but no ppt. and are of doubtful value, especially in old baths; (3) those which immediately form a flocculent ppt., leaving a clear soln. These are useless except under special conditions. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 6569.) (W)

Soluble Nitrogen in Wool: Determination of—According to Sauer's Method. R. Folgner and G. Schneider. *Monatschr. Textil-Ind.*, 1934, V. 49, P. 181–2; *Chem. Abs.*, 1934, V. 28, Col. 7028. (W)

Testing Results: The Principle of Probability in the Evaluation of. Dr. Irving J. Saxl. *Am. Silk and Rayon J.*, 1934, V. 53, No. 11, P. 29–32, 54.

This is a paper presented before the American Society for Testing Materials at their October 19th meeting in New York City. Certain principles of statistical treatment of data are utilized to indicate the lack of reliability which may frequently be placed on the arithmetic mean in an attempt to substitute for it a distribution effect. The author states that it is of greater importance to know the amount of breakage which would be expected from a certain type of yarn than it is to know the average mean strength of the yarn. It is pointed out that a good average with a wide spread of strength may give a much poorer manufacturing result than a yarn of a lower mean strength but with a smaller spread. Statistical treatment of the data to determine the degree of spread and certain empirical results based on tests on rayon yarn are included together with a typical example worked out in detail. (S)

Testing the Tensile Strength, Breaking Tension and Elasticity of Fibres, Yarn and Other Textiles: New Apparatus for. *Monatschr. Textil-Ind.*, 1934, V. 49, P. 97–8.

The app. called Deforsenk app., which is shown by a schematic drawing, can be used with a load up to 1000 g. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 7023.) (W)